International Journal of Civil Engineering and Technology (IJCIET)
Volume 7, Issue 1, Jan-Feb 2016, pp. 93-103, Article ID: IJCIET_07_01_008
Available online at
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=7&IType=1
Journal Impact Factor (2016): 9.7820 (Calculated by GISI) www.jifactor.com
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

INFLUENCE OF STEEL FIBERS AS ADMIX IN NORMAL CONCRETE MIX

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ABSTRACT

In recent days the usage of concrete has been increased all over the world. Hence it is important to study the mechanical properties of concrete on addition of mineral admixtures. Our main motive is to know the compression behavior of concrete when different types of mineral admixtures added to the concrete. The mineral admixture we are using in this study are steel fibres. In this study we are casting 6 cubes and 6 cylinders out of which 2 each for 7, 14, 28 days. The percentage addition by weight of concrete for mineral admixtures used are 2% and 4%. We are going to compare the results of compression strength and split tensile strength of concrete with normal concrete when admixtures are added to the concrete with different percentages. The experimental study on normal strength concrete grade for 2% and 4% cube were also prepared respectively.

Key words: Steel fibres, Cement and Compressive Strength.

Cite this Article: I. Siva Kishore and Ch. Mallika Chowdary. Influence of Steel Fibers as Admix in Normal Concrete Mix. *International Journal of Civil Engineering and Technology*, **7**(1), 2016, pp. 93-103.
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1. INTRODUCTION

1.1. FIBRE REINFORCED CONCRETE

1.1.1. General

Concrete is acknowledged to be a relatively brittle material when subjected to Normal stresses and impact loads, where tensile strength is approximately just one tenth of its compressive strength. As a result for these characteristics, concrete flexural members could not support such loads that usually take place during their service life. Historically, concrete member reinforced with continuous reinforcing bars to withstand tensile stresses and compensate for the lack of ductility and strength. Furthermore, steel reinforcement is adopted to overcome high potentially tensile stresses and shear stresses at critical location in concrete member. Even though the addition of steel reinforcement significantly increases the strength of concrete, the

development of micro cracks must be controlled to produce concrete with homogenous tensile properties. The introduction of fibres is brought in as a solution to develop concrete with enhanced flexural and tensile strength, which is a new form of binder that could combine Portland cement in bonding with cement matrices. Fibres are most generally discontinuous, randomly distributed throughout the cement matrices. According to terminology adopted by the American Concrete Institute (ACI) Committee 544, in Fibre Reinforced Concrete, there are four categories namely:-

SFRC – Steel Fibre Reinforced Concrete

GFRC – Glass Fibre Reinforced Concrete

NFRC – Synthetic Fibre Reinforced Concrete

NFRC – Natural Fibre Reinforced Concrete.

1.1.2. Concrete

The inclusion of fibres in concrete is to delay and control the tensile cracking of composite material. Fibres thus transform inherent unstable tensile crack propagation to a slow controlled crack growth. This crack controlling property of fibre reinforcement delays the initiation of flexural and shears cracking. It imparts extensive post cracking behavior and significantly enhances the ductility and the energy absorption capacity of the composite. Earlier fibre-reinforced concrete was used in pavements and industrial floors. But subsequently, Fibre Reinforced Concrete have wide variety of usages in structures such as heavy-duty pavements, Airfields, industrial floor, water retaining and hydraulic structures, parking structure decks, water and waste water treatment plants, pipes, precast roof and wall panels, and the techniques of concrete application.

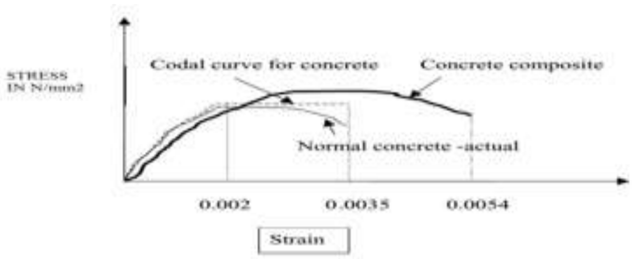


Figure 1.1 Showing Codal provisions of Concrete

1.1.3. Limitations of Fibre Reinforced Concrete

Fibres, which are randomly distributed throughout the concrete, can overcome cracks and control shrinkage more effectively. These materials have outstanding combinations of strength and energy absorption capacity. In general, the fibre reinforcement is not a substitution to conventional steel reinforcement. The fibres and steel reinforcement have their own role in concrete technology. Therefore, many applications in which both fibres and continuous reinforcing steel bars can be used together. However, fibres are not efficient in withstanding the tensile stresses compared to conventional steel reinforcements. But, fibres are more closely spaced than steel reinforcements, which are better in controlling crack and shrinkage. Consequently, conventional steel reinforcements are used to increase the load bearing capacity of concrete member; fibres are more effective in crack control. The lack of corrosion resistance of normal steel fibres could be a disadvantage in exposed

concrete situations. The synthetic fibres are uneconomical to medium level people. Fire resistance of synthetic fibres is also needed to be evaluated.

For example, 1 m^3 of concrete will cost about Rs. 5,000/-. If 1% of steel fibre is put to 1m^3 of concrete, the cost of steel fibres would come around Rs.5, 000/-. Hence people living in rural areas that always prefer the non-engineered constructions cannot use these fibres. So for medium level constructions, particularly located in medium to high seismic prone areas locally available new construction materials which would cost are required to be cost effective.

1.1.4. Properties of Steel Fibre

Table 1.1 Showing Properties of steel fibres

Cross Section	Straight , hook- end deformed
Diameter	0.3-0.7mm (max 1n
Length	25 – 35mm
Density	7900 kg/m3
Young‘s Modulus	2.1 x 105 N/mm2
Resistance to Alkalis	Good
Resistance to Acids	Poor
Heat resistivity	Good
. Tensile Strength	500-2000 N/mm2
Specific Gravity	7.90
Aspect Ratio	45, 55, 65, 80
General Use	10 kg/m3
Elongation	5-35 %

1.2. Types of Steel Fibres

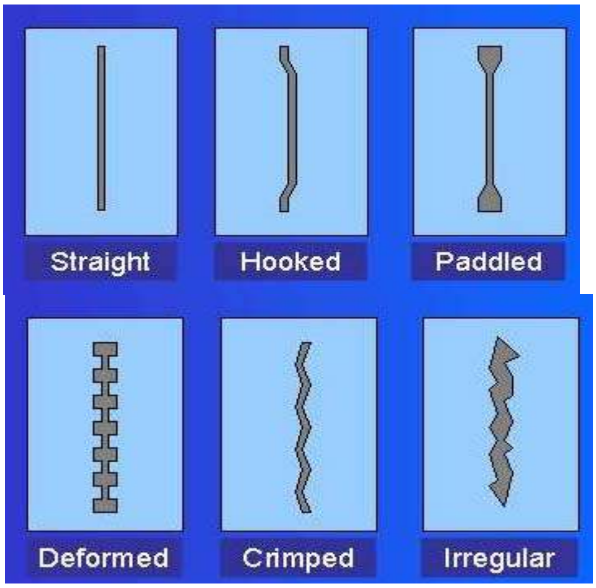


Figure 1.2 Different types of Steel fibers

2. METHODOLOGY

The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratios of cement, fine and coarse aggregates. For e.g., a concrete mix of proportions 1:2:4 means that cement, fine and coarse aggregate are in the ratio 1:2:4 or the mix contains one part of cement, two parts of fine aggregate and four parts of coarse aggregate. The proportions are either by volume or by mass. The water-cement ratio is usually expressed in mass

3. MATERIALS REQUIRED

1. Cement
2. Fine aggregate
3. Coarse aggregate
4. Water
5. Admixtures
6. Steel fibres

3.1. Cement

Ordinary Portland cement (OPC) is by far the most important type of cement. The OPC was classified into three grades namely, 33 grade, 43 grade and 53 grade depending upon the strength of the cement at 28days when tested as per IS 4031-1988. In our project we are going to use 53 grade cement.

3.2. Fine Aggregate

It should be passed through IS Sieve 4.75 mm. It should have fineness modulus 2.50-3.50 and silt contents should not be more than 4%.

3.3. Coarse Aggregate

It should be hard, strong, dense, durable and clean. It must be free from vein, adherent coatings and injurious amount of disintegrated pieces, alkalis, vegetable matters and other deleterious substances. It should be roughly cubical in shape. Flaky pieces should be avoided. It should confirm to IS 2838(I).The maximum size of the aggregate we are using should not be more than 20mm.

3.4. Water

Water should be free from acids, oils, alkalies, vegetables or other organic impurities. Soft waters also produce weaker concrete.

3.5. Admixtures

An admixture is defined as a material, other than the cement, water and aggregate, i.e. uses as an ingredient of concrete and is added to the batch immediately before or during mixing**.** The different admixtures that we are going to use in our project Steel fibres are used.

3.6. Steel Fibres

Diameter Varying from 0.3-0.5 mm (IS: 280-1976)

Length varying from 35-60 mm

Density of steel fibres is 7900 kg/cum

Table 3.1 Mix proportions of M_{30} concrete mix

W/C Ratio	Water	cement	fine aggregate	coarse aggregate
0.45	175.5 L	390 kg/m^3	630.54 kg/m^3	1189.2 kg/m^3
0.45	0.45	1	1.62	3.04

4. EXPERIMENTAL WORK

The experimental program consisted of casting and testing of concrete cubes, cylinders, of sizes as mentioned below. The complete details of test samples are given in table form gives the various % replacement of cement adopted for the experimental program.

Table 4.1 Percentage of Steel Fibres added

% added	Size of cubes (mm)	Size of cylinders (mm)	No of cubes	No of cylinders
0%	150*150*150	150dia,300ht	6	6
2%	150*150*150	150dia,300ht	6	6
4%	150*150*150	150dia,300ht	6	6

4.1. Mixing of Constituent Materials

The cement and admixture were measured and mixed together until a uniform colour was obtained. The blended mix was spread on already measured fine aggregate placed

on an impermeable platform and mixed thoroughly before the coarse aggregate and water were added.

4.1.1. Casting and Curing of Specimens

The specimens were cast in well lubricated moulds. Concrete were placed on the mould and compacted thereafter and they were left at room temperature for 24hrs before being transferred into the curing tank. After 24 hours, they were immersed in water curing tanks until their testing ages. To investigate the effect of thermal dust, sugarcane bagasse and steel fibers when used as admixtures, 150 mm cube specimens, 150mm diameter and 300mm height cylinder specimens were cast for referral and other mixes having variable admixture content.

4.1.2. Testing of Specimens

The compressive strength of different mixes was found out at 7 and 28 days whereas Split Tensile Strength and Flexural Strength were found out at 28 days as per the procedure laid down in IS: 516 - 1981.The concrete specimens were tested for compressive strength and tensile splitting strength in a compression testing machine of capacity 2000KN and flexural Strength was tested in a Flexure Strength Testing Machine respectively. Three specimens were used in computing the mean on each testing age of each mix and the final results are tabulated in comparison with reference mix.

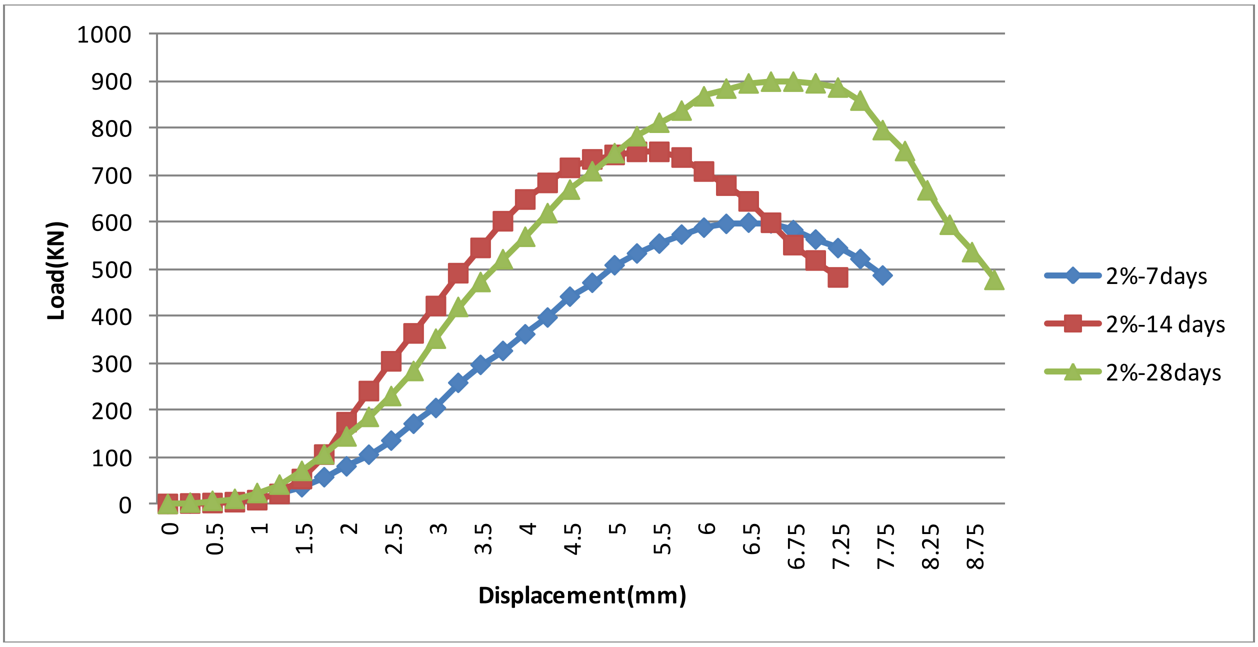
4.1.3. Testing

1. Tests shall be conducted at the end of 7 days and 28 days. The tests should be carried out immediately upon the removal of specimens from water.
2. Measure the dimensions of the given specimen.
3. Keep the specimens in compression testing machine so that the load is applied to the transverse sides as cast and not to the top and bottom sides as cast. The rate of loading should be 140 kg/sq.cm/minute.
4. Note the mode of failure and angle of plane on which the specimen fails. Record the ultimate load reach during the test.

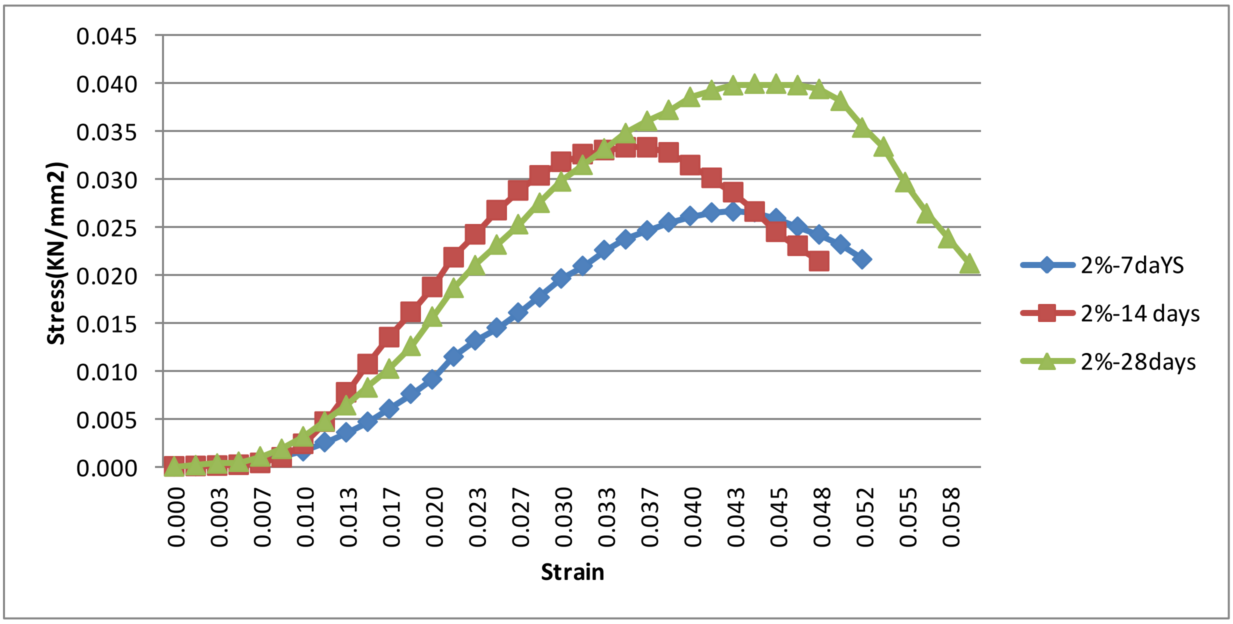
5. RESULTS OF STEEL FIBRES

Table 5.1 Showing compressive strength and split tensile strength values

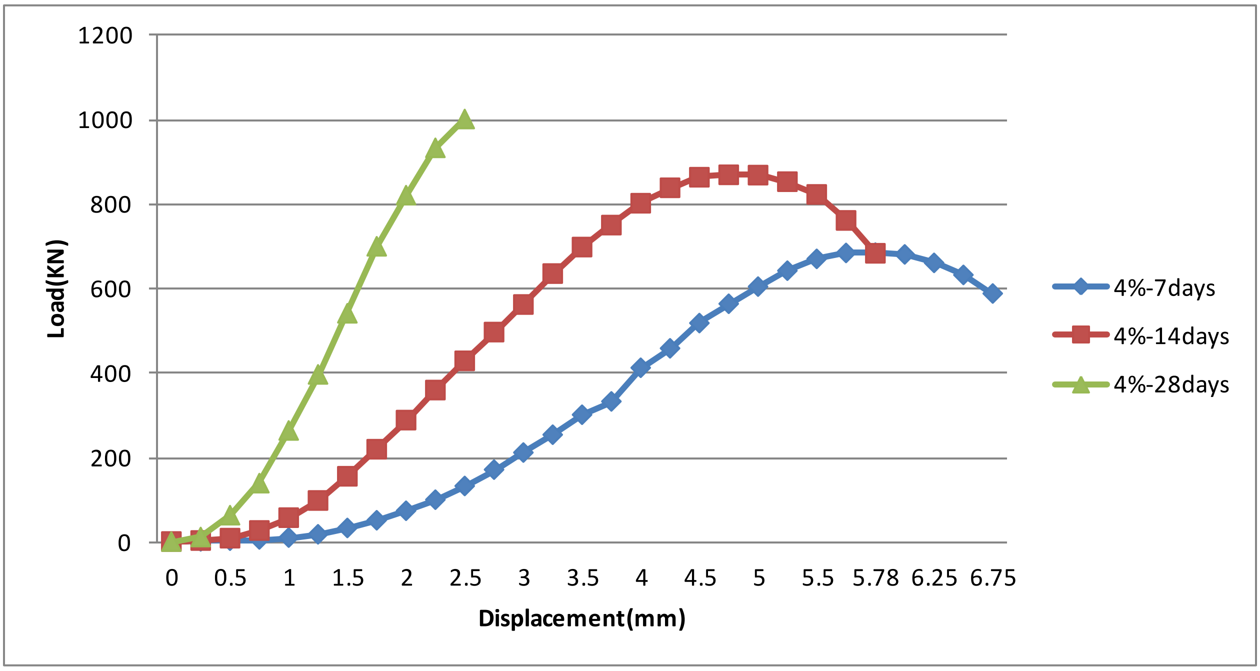
Percentage of admixture added	**W/C Ratio**	**7 Days Compressive Strength(N/mm^2)**	**14Days Compressive Strength(N/mm^2)**	**28 Days Compressive Strength(N/mm^2)**	**28 Days Tensile Strength(N/mm^2)**
0%	0.45	26	26.5	30	2.4
2%	0.45	32	33	39	2.7
4%	0.45	35.5	39	44	3.4



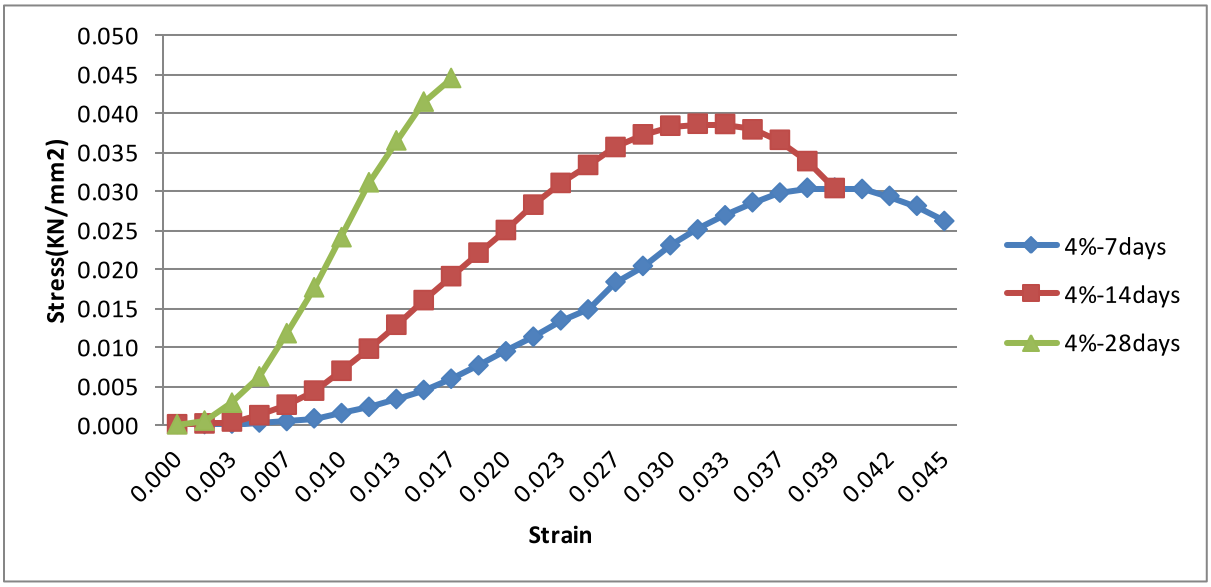
Graph 5.1 Cube Strength 2% steel fibres (Load vs Displacement curve)



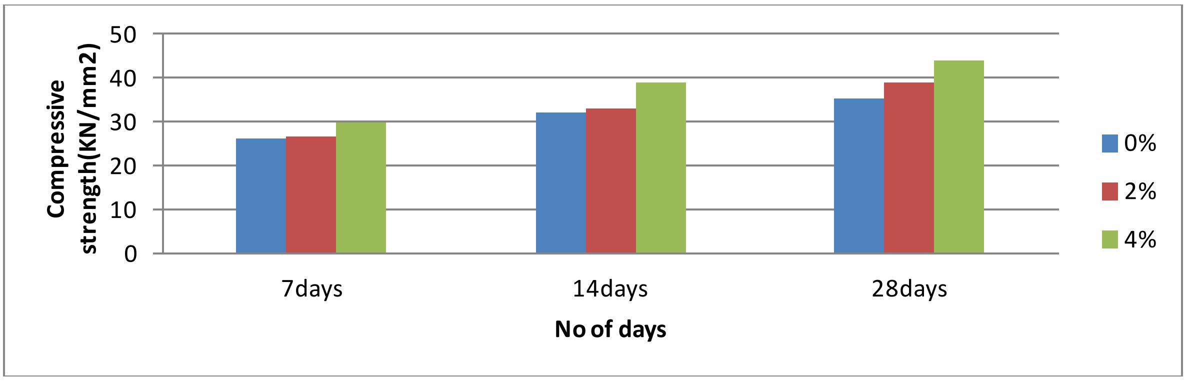
Graph 5.2 Cube Strength - 2% steel fibres (stress vs Strain curve)



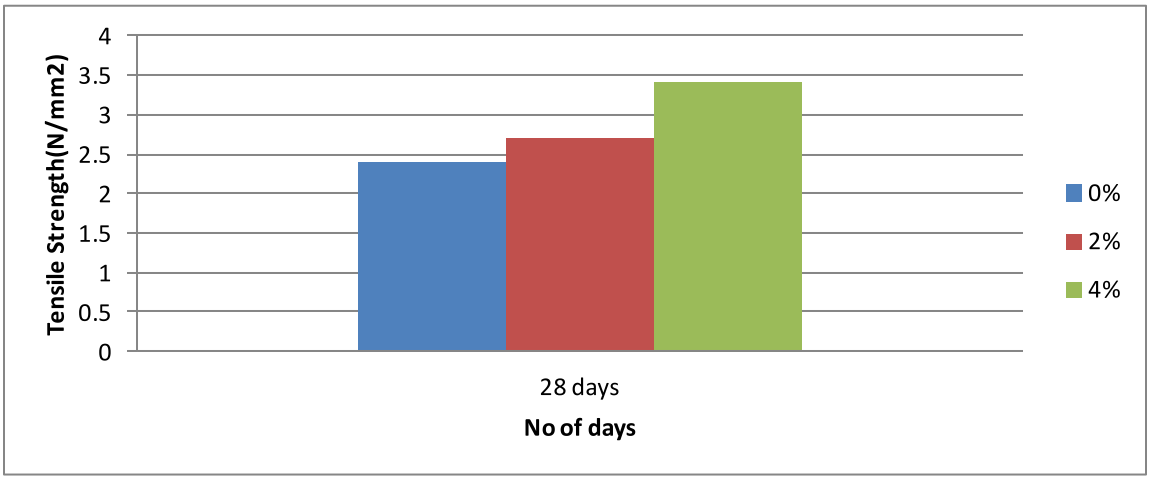
Graph 5.3 Cube Strength - 4% steel fibres (Load vs Displacement)



Graph 5.4 Cube Strength - 4% steel fibres (stress vs Strain curve)



Graph 5.5 Comparisons of Compressive Strength values



Graph 5.6 Comparisons of Split Tensile Strength values

6. CONCLUSIONS

Based on the test results obtained from the study, the following conclusions are drawn:-

- From the results, we can observe that the compression strength and split tensile strength increases with the increase in the percentage of an admixture Steel fibres.
- This binding nature helps in bonding. Here the bonding is good then these fibers can withstand for heavy loads.
- As the percentage of admixture increased the strength of the concrete is also increased in case of steel fibres.
- Aspect Ratio= (Length/Diameter) and strength are inversely proportional. This ratio of hooked steel fibres is less and hence this also may be the reason for the increase of strength.
- Steel fibre is an Artificial Fibre which is used for the longer life span of the structure, which are not much costlier and by this the normal grade of the concrete also can give good results with longer life of the structure
- The workability of concrete is satisfactory with steel fibres.

Figure 6.1 Cubes with steel fibres

Figure 6.2 Before testing (Steel fibres)

Figure 6.3 After testing (Steel fibres)

REFERENCES

[1] Perumalsamy N. Balaguru, Sarendra P. Shah, ‘‘Fiber reinforced cement composites’’, Mc Graw Hill International Editions 1992.

[2] Ganesan and J.V. Ramana Murthy, "Strength and Behaviour of Confined steel Fibre Reinforced Concrete Columns", ACI Materials Journal, American Concrete Institute, Vol.87, No.3, May-June 1990, pp. 221-227.

[3] P. N. Balaguru and S. P. Shah, “Fiber Reinforced Cement Composites", McGraw-Hill Inc; 1992.

[4] Parviz Soroushian and Cha-Don Lee. Publication: Materials Journal. Volume: 87. Issue ... tension; tests; Materials Research. Date: November 1, 1990.

[5] Fiber-reinforced concrete: an overview after 30 years of development

[6] “Cracking characteristics of R.C. beams with steel fibres”, Proceeding of the international symposium on fibre reinforced concrete. Dec. 16-19, 1987, Madras, India PP. 2.59-2.68.

[7] Ganesan, N. and Ramana Murthy, J.V. (1990), “Strength and behavior of confined steel fiber reinforced concrete columns” ...

[8] M.Ziad Bayasi; Parviz Soroushian. Effect of steel fiber reinforcement on fresh mix properties of concrete. ACI Materials Journal. 1992; 89(4):369-374. 21. 19. 1991.

[9] Balaguru, P. N., and Shah, S. P. (1992). Fiber-reinforced concrete composites. McGraw-Hill, New York. Balaguru, P. N. (1992).

[10] I. Siva Kishore and Ch. Mallika Chowdary. A Study on Waste Utilization of Marble Dust in High Strength Concrete Mix. *International Journal of Civil Engineering and Technology*, **6**(12), 2015, pp. 1-7.

[11] N.Ganesan, Bharati Raj, A.P.Shashikala and Nandini S.Nair. Effect of Steel Fibres on the Strength and Behaviour of Self Compacting Rubberised Concrete. *International Journal of Civil Engineering and Technology*, **3**(2), 2012, pp. 94-107.